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OPTIMUM DOSAGE OF ACTIVATED CARBON ON THE REMOVAL OF TOXIC METALS FROM WASTE WATER

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Abstract - *Due to rapid urbanization, globalization and population explosion, various forms of pollution are a great threat to the society and environment. Over the recent decades, pollution of water bodies is mainly due to disposal of industrial wastes either in the form of solid or liquid, directly into the water bodies without any treatment. Contaminants present in water bodies are sometimes toxic or hazardous in nature which might cause huge problems to the environment. Removal of toxic elements from the waste is quietly a difficult task to make the waste water clean from toxic components. This study mainly focuses on the removal of toxic or heavy metal elements (like Nickel [Ni] and Lead [Pb]) from the artificially prepared waste water in the laboratories which could replicate the exact waste water obtained from industry outlets. Adsorption process for the removal of toxic metals from the waste water gives appreciable results over the years of conducting experiments by various researchers with the help of activated carbons (AC). Even the activated carbons are used extensively in waste water treatment, they remain expensive. In order to treat or remove the toxic metals from waste water, researches were conducted to identify the low-cost alternatives to produce the AC. In this study, two different materials named river tamarind fruits and tamarind fruit shell were used to make the AC. The synthetic nickel and lead solutions were prepared with 64ppm and 50ppm concentration of nickel and lead, and with a pH value of 8.4 and 3.8 respectively were used. Activated carbons are added into the waste solution, Experiments were conducted to find the optimum dosage of activated carbon, toxic metal concentration and optimum contact time.*

Key Words: Toxic metal removal, Activated Carbon, Adsorption technique, Optimum dosage.

1. INTRODUCTION

Earth crust is composed different variety and forms of elements which includes various toxic metals like Ni, Pb, Zn, Cd, Cr. When the living things are exposed to heavy or toxic metal exposure of very low level, it might also cause high risks. Presence of above-mentioned toxic metals in water bodies directly affects the human being and other aqueous bio diversity. These heavy metals won't be completely eradicated naturally from the water bodies, once the pollution was made at higher level [1]. Table 1 shows the permissible range of pollutants as per BIS standards that can be present in water bodies due to the disposal of industrial effluents.

Table -1: Permissible limits of Toxic metals as per BIS

Parameter	Pollutant (mg/l)	
	Ni	Pb
Drinking water	-	0.05
Into Inland Surface Waters	3	0.1
Into Public Sewers	3	1
On land for Irrigation	-	-
Into Marine Coastal Areas	5	1

Over the extensive researches done by the scientists, environmentalists and engineers, recent techniques like adsorption, precipitation, filtration and ion exchange were produces better results on the removal of toxic metals from the waste water solution. Adsorption technique has proven to be economical and efficient method for the removal of toxic metals and other pollutants from waste water [4]. Activated carbon has shown to be an efficient adsorbent for the removal of a wide variety of organic and inorganic contaminants present in the aquatic environment.

Unlike organic pollutants, the majority of which are susceptible to biological degradation, toxic metals do not degrade into harmless end products over the period of time. Presence of toxic or heavy metals in the water bodies highly affects the bio-diversity. The major sources of heavy metals in waste water were from the disposal of untreated wastes from the industries like plating, mining, tanneries and alloy industries [6]. In recent decades, usage of activated carbons as adsorbents in waste water was a widely used technique which could shows the safe and economical methods for the removal of toxic metals.

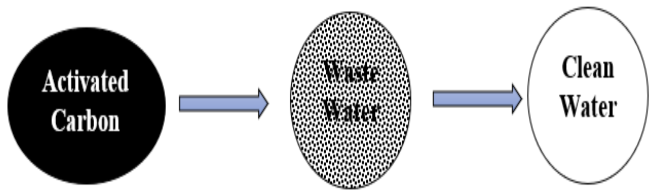

Fig -1: Adsorption Technique with the use of AC

Over the years, numerous waste products from agricultural industries like rice husk, coconut husk, saw dust, neem bark, fruit peels, etc., were used for the production of adsorbents, in order to remove the toxic or heavy metals from the waste water. In general, an adsorbent can be termed as a low-cost adsorbent if it requires little processing, is abundant in nature, local availability or is a by-product or waste material from another industry. But improvement of sorption capacity may compensate the cost by additional processing [2] [6]. The objective of this study is to contribute in the search for less expensive adsorbents and their utilization possibilities for various agricultural waste by-products, which are in many cases also pollution sources. In this study, two different waste products named river tamarind fruits and tamarind fruit shell which are available abundantly in local sources were used to produce AC's (see Figure 2).

River Tamarind Fruit Tamarind Fruit Shell

Fig -2: Tamarind Waste Materials

2. MATERIAL PROPERTIES AND METHODS

2.1 Preparation of Activated Carbons

River tamarind fruits (RTF) are only used for architectural or ornamental purposes and after it falls from the tree, it simply goes as waste. Tamarind fruits are collected during the season, & their shells (TFS) are thrown out as wastes. The collected wastes are dried and shredded into small pieces. Then, thermal activation was done through Standard methods. Then it was washed with distilled water, oven-dried at 100^0C for one hour, sieved to the size of 710-500μ and used in the experiments [3] [8]. Various properties of prepared AC's from the waste materials are illustrated in Table 2.

Table -2: Properties of AC

Property	RTF	TFS
Moisture content (%)	4.01	3.35
pH	10.2	9.31
Bulk density (g/cc)	0.44	0.42
Surface area (m^2/g)	385	378
Volatile matter (%)	48.2	27

2.2 Preparation of Waste water solution

The waste water solution containing nickel was collected from the local plating industries and the nickel concentration was diluted to 64ppm which is harmless while laboratory testing and handling. Lead solution with a concentration of 50ppm was produced with analytical grade lead nitrate salt. pH value of the prepared waste water solution with Ni and Pb was kept constant as 8.4 and 3.8 throughout the investigation.

2.3 Batch experiments

Batch adsorption experiments were conducted in order to predict the abilities of prepared AC's, where constant volume of waste water along with the different dosage of AC.

2.4 Dosage of AC

The amount of AC required per litre of waste solution to be treated and contact time required were established. 100ml of waste water solutions (both Ni and Pb) were taken in 8 different conical flasks and different dosage of AC's made with RTF and TFS (1g, 2g, 3g and 4g) were added and agitated. At regular interval (5 min) the residual concentration of toxic metals was measured by using Atomic absorption spectrophotometer.

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3. RESULTS AND DISCUSSIONS

In this type of batch experiment, it was aimed at establishing the Optimum Dose and the Optimum Contact Time. In this batch adsorption experiment, the pH value and the metal concentration in the aqueous solution were kept as constant. 100 mL of the aqueous solution was equilibrated with different dosages of the adsorbent. At regular intervals, the residual toxic metal concentrations were monitored. Table 3 and 4 illustrates the Ni and Pb concentrations obtained during the period of batch experiments.

Table -3: Removal of Ni and Pb from Waste solutions with activated carbons made by RTF

Contact time (sec)	Concentration (ppm)				% of Removal	
	Initial		Residual			
	Ni	Pb	Ni	Pb	Ni	Pb
Dosage of AC: 1 (gm/100ml)						
300	64	50	20.2	8.5	68.5	83.1
600	64	50	12.2	4.2	80.9	91.6
900	64	50	11.9	2.9	81.4	94.1
1200	64	50	11.7	2.7	81.7	94.6

1500	64	50	11.4	2.4	82.2	95.2
1800	64	50	11.1	2.6	82.7	94.8
Dosage of AC: 2 (gm/100ml)						
300	64	50	12.1	7.2	81.0	85.6
600	64	50	4.3	3.8	93.3	92.5
900	64	50	3.9	2.1	94.0	95.8
1200	64	50	3.5	1.9	94.6	96.2
1500	64	50	3.2	1.8	94.9	96.4
1800	64	50	3.0	1.7	95.3	96.7
Dosage of AC: 3 (gm/100ml)						
300	64	50	11.4	6.1	82.2	87.9
600	64	50	3.8	2.8	94.1	94.4
900	64	50	3.6	1.2	94.4	97.7
1200	64	50	3.0	1.0	95.3	97.9
1500	64	50	2.8	1.0	95.6	97.9
1800	64	50	2.6	0.8	95.9	98.3
Dosage of AC: 4 (gm/100ml)						
300	64	-	10.2	-	84.0	-
600	64	-	3.1	-	95.1	-
900	64	-	2.8	-	95.6	-
1200	64	-	2.5	-	96.1	-
1500	64	-	2.3	-	96.4	-
1800	64	-	1.9	-	97.1	-

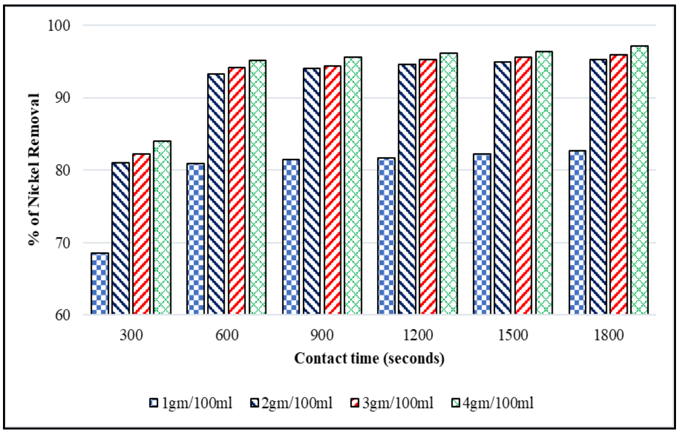

Chart -1: Removal of Ni from Waste solutions with activated carbons made by RTF

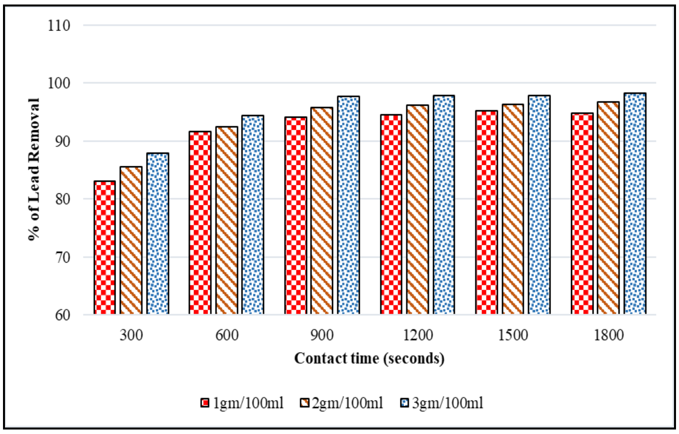

Chart -2: Removal of Pb from Waste solutions with activated carbons made by RTF

Table -4: Removal of Ni and Pb from Waste solutions with activated carbons made by TFS

Contact time (sec)	Concentration (ppm)				% of Removal	
	Initial		Residual			
	Ni	Pb	Ni	Pb	Ni	Pb
Dosage of AC: 1 (gm/100ml)						
300	64	50	19.6	25.6	69.3	48.9
600	64	50	14.1	17.7	77.9	64.6
900	64	50	13.7	13.2	78.6	73.7
1200	64	50	13.4	12.8	79.1	74.3
1500	64	50	13.3	12.5	79.3	75.0
1800	64	50	13.1	12.1	79.6	75.8
Dosage of AC: 2 (gm/100ml)						
300	64	50	12.3	9.6	80.8	80.8
600	64	50	6.6	6.1	89.7	87.7
900	64	50	6.3	3.3	90.2	93.3
1200	64	50	6.0	3.1	90.6	93.7
1500	64	50	5.7	3.0	91.1	94.0
1800	64	50	5.5	2.8	91.4	94.4
Dosage of AC: 3 (gm/100ml)						
300	64	50	10.9	8.0	83.0	84.0
600	64	50	4.6	5.0	92.8	90.1
900	64	50	4.3	1.8	93.3	96.3
1200	64	50	4.2	1.6	93.4	96.8
1500	64	50	4.0	1.6	93.8	96.8
1800	64	50	3.9	1.5	93.9	97.0
Dosage of AC: 4 (gm/100ml)						
300	64	-	9.8	-	84.7	-
600	64	-	3.1	-	95.1	-
900	64	-	2.9	-	95.4	-
1200	64	-	2.8	-	95.6	-
1500	64	-	2.5	-	96.1	-
1800	64	-	2.4	-	96.3	-

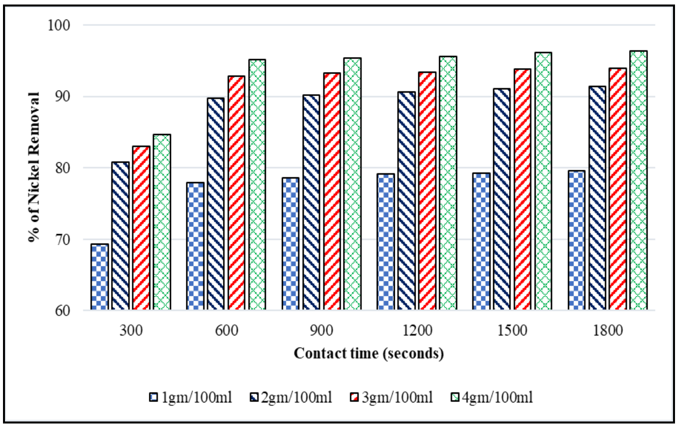

Chart -3: Removal of Ni from Waste solutions with activated carbons made by TFS

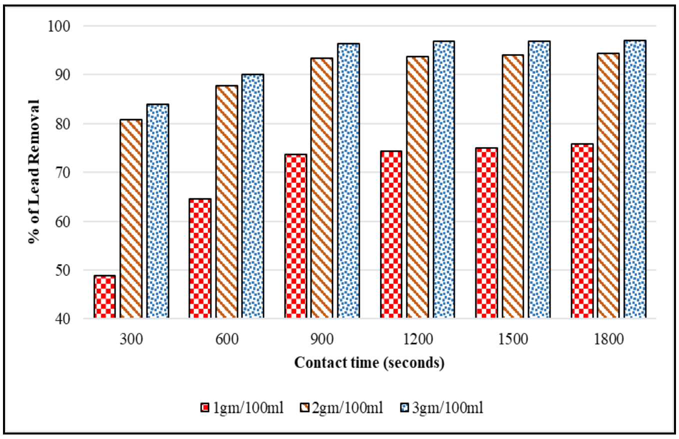

Chart -4: Removal of Pb from Waste solutions with activated carbons made by TFS

From Figure 3 to 6, it is observed that, increase in contact time proportionately increases the amount of metal adsorption in waste solutions. It is also observed that percentage of Ni removal by both types of activated carbons shows almost similar results, and more than 60% of Ni concentration was adsorbed with the use AC at a rate of 1gm/100ml. Activated carbons made with RTF shows optimum contact time and optimum dosage of 600 seconds and 2gm/100ml while removing the Ni and Pb contents from waste solution respectively. Activated carbons made with TFS shows optimum contact time and optimum dosage of 900 seconds and 2gm/100ml while removing the Ni and Pb contents from waste solution respectively.

4. CONCLUSIONS

The following are the conclusions are drawn from the experimental investigation done on the treatment of waste water with the use of activated carbons.

- It is possible to create low cost activated carbons with the usage of locally available waste materials.
- Activated carbons made with both RTF and TFS shows notable results on the removal of toxic metal concentration.
- Increase in contact time proportionately increases the amount of metal adsorption in waste solutions.
- Percentage of Ni removal by both types of activated carbons shows almost similar results, and more than 60% of Ni concentration was adsorbed with the use AC at a rate of 1gm/100ml.
- Activated carbons made with RTF shows optimum contact time and optimum dosage of 600 seconds and 2gm/100ml while removing the Ni and Pb contents from waste solution respectively.
- Activated carbons made with TFS shows optimum contact time and optimum dosage of 900 seconds and 2gm/100ml while removing the Ni and Pb contents from waste solution respectively.

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